

Model Based Definition

An extract for the DETC MBD white paper

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In September 2007, the Engineering Directorate at the Marshall Space Flight Center (MSFC) created the Design System Focus Team (DSFT). MSFC was responsible for the in-house design and development of the Ares 1 Upper Stage and the Engineering Directorate was preparing to deploy a new electronic Configuration Management and Data Management System with the Design Data Management System (DDMS) based upon a Commercial Off The Shelf (COTS) Product Data Management (PDM) System. The DSFT was to establish standardized CAD practices and a new data life cycle for design data. Of special interest here, the design teams were to implement Model Based Definition (MBD) in support of the Upper Stage manufacturing contract. It is noted that this MBD does use partially dimensioned drawings for auxiliary information to the model.

To support implementation of DDMS, MBD, and a new data lifecycle; the design groups needed to work together in the definition and implementation of standard practices. Critical design activities that were targeted included configuration management of CAD models, drawings, and integration of the models into top-level assemblies.

By April 2008, the Director of Engineering implemented the first recommendations by the DSFT:

- Begin migration to a new modular product architecture (MPA) based on explicit identification and management of interfaces between product modules.

- Begin use of Work Group Approval (WGA) Process for configuration control of CAD files prior to formal Release.

- Use a Designer's Checklist that implements the new CAD standards.

- Implement the policy "Model is the Master" where manufacturing would be accomplished to the released CAD model.

A Pathfinder was commissioned for the Upper Stage common bulkhead to exercise these new practices. The Pathfinder ran for seven (7) months and completed in August 2008. A significant number of issues were identified and the DSFT worked diligently to close all 21 of the priority 1 items.

A second Pathfinder activity aimed at releasing a smaller assembly was based on the ullage settling motor assembly to demonstrate the improved practices. Four problems were identified and corrected through modifications to training and the Designer's Checklist. The resulting standards and practices were documented in MSFC-STD-3528 Computer Aided Design Standard, the Designer Checklists, a set of 29 Desktop Instructions, and the Physical Interface Matrix which identified specific Upper Stage controlled interfaces.

Work Group Approval Process

The design data lifecycle implemented several new release states to be used prior to formal release that allowed the models to move through a flow of progressive maturity. These use the read and write capabilities within DDMS to set the access controls as defined by the lifecycle states.

While designers are initially working on the CAD models, the DDMS state is In-Work. The files are not seen by others until the designer feels comfortable with the maturity of the files. When the designer approves the models to be seen by others in the design team, the state in DDMS is set to Design. In this state, the models are stable and set with Read Only permissions. The designer uses the Designer's Checklist to ensure that the file is free from errors and compliant with the CAD standard. Most of the design iterations occur between In-Work and Design. The community at large would recognize that whenever a file was in the Design state, it was available for reference but the user would know that it was still in development. This provided a significant stability to the upper level assemblies.

The next state in DDMS in the progressive maturity is Workgroup Approved. Approval of promotion to this state requires branch chief approval and implements a "prerelease" level of maturity that was needed for final analysis or formal review, particularly a Critical Design Review. As a result, a shorter review time for final release would be needed since the detail analysis and review had already occurred.

These new design data lifecycle additions lead up to the traditional formal release. The designer initiates a Change Request to start the approval cycle and the model and drawing enter the DDMS state Under Review. Electronic approvals are collected from Checking, Designer, Materials, Producibility, Stress, Safety and Mission Assurance, Branch Chief and the next higher assembly. When the model is processed through the release desk, the DDMS state is Released.

Lessons Learned

The DSFT identified some 17 Lessons Learned as outcomes of the standards development, pathfinder deployments and initial application to the Upper Stage design completion. Due to space limitations, not all can be presented here, but the following are a few of the high value examples.

Quickly Identify the Current State of the Environment

The Pathfinder test case brought out the extent of the problems through trial use with a real assembly. In some cases, these were unknown to the design and configuration management community. Running Pathfinder 1 and Pathfinder 2 exercises set the stage for development of the CAD standard, best practices and the WGA design data lifecycle.

Identify Lifecycle States within the Design Process

A clear definition of each state and a clear understanding by the user community of the intention and criteria for each state are critical to ensuring that models are ready to be shared by the community, particularly the assembly engineering group.

Develop a CAD Standard

All design organizations must follow the same standard for developing models and drawings. The CAD standard is a directive on how models are created within the frame of a specific CAD platform. It is

critical that every designer abide by this standard and that there be no exceptions in the mandatory use of the standard for any project or program.

Ensure First Level Supervisors have Buy-In and Acceptance of the Solutions and Ensure Senior Management Communicates their Acceptance and Direction to follow the Solutions

The first level managers supply the personnel to accomplish the design activities. The DSFT requested recommendations and worked through the impact of the DSFT decisions on the supervisors' work commitments. Communications need to be open and free of hidden agendas to make sure these supervisors know the status of the implementation on a regular basis.

Prior to issuing a directive, official Engineering Directorate memoranda were distributed and the discussed in designer's forums. This gave everyone an opportunity to impact the directive and how it would be implemented.

Make Sure Senior Management is Informed Regularly of Progress and Problems

Formal reports were made to the management council and weekly working meetings were held to address needed corrective actions. Accomplishments, upcoming events and broad issues were discussed at the tri-weekly management stand-up meetings.

Make Sure that there is Agreement on when Files can be used by the Broader Design Community

Encourage the use of a schedule of major design state dates published by the assembly engineering organization for all design activities, but developed in conjunction with the design branch chiefs. This provides real milestones for the push to the Design state. In return, the designer accepts the responsibility of pushing the models to the Design state as often as possible prior to the due date to aid the assembly engineers.